PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Antennas and Material for the Manufacture thereof

We, RAYMOND DE-ICER AND ENGINEERING CO., INC., a corporation organised and existing under the laws of the State of California, United States of America, of 5300 Pacific, Huntington Park, California, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a structure capable of use to form a radio antenna and consisting essentially of one or more layers of an initially non-conductive woven fabric rendered electrically conductive by the deposition of metal thereon and sealed within an envelope of a solid synthetic resin.

The invention is concerned with a material of the above description which is particularly adapted to the fabrication of antennae for sending and receiving radio and radar waves. Such an antenna may be of relatively very light weight and completely waterproof and incapable of being shorted-out by rain, fog or dew. It may be formed as part of the skin of an airplane without weakening of the structure; as a directional antenna in which the sending or receiving surface may readily be arranged in a true plane; as an antenna of rod-like form which is both light and stiff and which may be supported from a single point, or as an antenna having any desired configuration of effective surface, however elaborate, which configuration will be maintained during the life of the structure.

According to the pressnt invention there is provided a structure adapted to send and receive electrical waves, said structure comprising a sheet of non-metallic woven fabric having metal deposited on a surface in quantity sufficient to render said sheet electrically conductive but insufficient to render said sheet impermeable to fluids, the metallized fabric being encased between layers of a waterproof, solid, electrically non-conductive resin, said layers being bonded together through pores in said fabric and around the periphery of said sheet.

In the accompanying drawings:

Fig. 1 is a plan view of an antenna of plane form constructed in accordance with the invention, and

Fig. 2 is a transverse section of Fig. 1.

In said figures, 10 and 11 indicate layers of a solid synthetic resin; 12 indicates a sheet of metallized woven fabric so proportioned as to leave a marginal zone 13 in which the resin layers coalesce to produce a tight seal, and 14 indicates an electrical conductor contacting the metallized surface and projecting beyond the boundary of the marginal seal.

It will be noted in connection with Fig. 2 (in which the relative thickness of the parts is exaggerated) that the cross-hatching of the resin is carried through the fabric layer 12 to indicate that the two resin layers are joined by the penetration of the resin through the interstices in the fabric; for certain purposes the fabric layer 12 may be constituted by more than one layer of fabric, while for certain purposes the conductor 14 may be omitted.

In constructing an antenna a woven, non-metallic fabric has continuous minute particles of metal deposited on its component fibres in such manner as to avoid choking of the interstices between the fibres, and the metallized fabric is embedded in a sealed envelope of a waterproof resin, the resin being caused to pass through the interstices in the fabric to form a unitary resin mass.

The fabric on which the metal is deposited may be of organic fibre such as cotton, linen, ramie, hemp, or jute, or it may be inorganic, as for example fibre-glass. The last named is the preferred material for use in the fabrication of antennae. Metallic fabrics such as woven wire cloth are unsuitable for the purpose of the invention and should not be used.

The metal used for metallizing the fabric may be any metal which is reasonably stable to the atmosphere, which has good electrical

conductivity, which is not brittle and which has a reasonably low melting point. Cadmium, lead, tin, zinc, copper and aluminium are all suitable and any other metal meeting the above requirements may be used. Zinc is the preferred metal by reason of its combination of low cost, moderate melting point and fairly high electrical conductivity.

The mesh of the fabric is variable over a wide range. One limit is that the space between the fibres or threads must not exceed the length of the wave to be sent or received. At the other end of the scale, the fabric must not be so tightly woven that the interstices will be filled by the deposited metal, or be so nearly choked that the particular resin used for the envelope will not penetrate it under the conditions of fabrication. Within the wide range thus permitted it will usually be desirable to select a fairly close weave as affording a greater fibre area for the reception of metal and thus a more effective antenna than a relatively open weave.

The deposition of the metal on the fabric is preferably but not necessarily performed by spraying a molten metal against the fabric in the manner customary in metallizing for other purposes. This is a well known art and no specific directions are required. In following the usual practice, in which a rod or wire of the metal is melted by a high temperature flame, it is well to hold the pressure of atomization at a level at which the velocity of the metal particles does not cause them to injure the fabric. This is particularly desirable in metallizing fibre-glass cloth.

A modified practice, which is economical in the spraying of large areas of cloth, is to maintain a supply of metal in molten condition and feed the liquid metal in a controlled stream into an atomizing jet of air or gas. This modification effects economy of fuel, permits closer regulation of temperature of application, and also permits some reduction in both temperature and velocity.

A sprayed metal may be applied to either or to both sides of the fabric. For many purposes an application to one side is sufficient and gives an antenna having the same capacity as one of equal area in which both sides are coated. For other purposes, as for example in making electrostatic shields it will be found that a single-side coating is only partially reflective while the double coating permits total reflection.

An alternative method of applying the metal is to draw a web of the fabric through a bath of the molten metal and apply high velocity jets of air or gas at right angles to the emerging surface before the metal on the surface has had time to solidify. This method is of limited applicability as while the air blast will free the interstices between the fibres, the coating itself is dense rather than porous, as in spraying. Further, the method is restricted to the use of metal alloys of melting point sufficiently low to avoid damage to the fabric, and is difficult to manipulate to produce a fabric of which less than the entire area is metal coated. Notwithstanding these drawbacks, the immersion method may be used and will often be found economical in the metallizing of large areas of fabric.

Contoured antennae, i.e., antennae provided with tongues, strips or islands of conductive material separated by non-conductive material, are often required. The desired forms may be provided either by cutting them from fabric of which the entire surface has been metal coated, or by masking portions of the surface of the fabric during the spraying operation and thus forming the desired pattern of coated surface on a continuous sheet of fabric.

The first named method is effective but requires more care in placing the metallized fabric in the mold, to avoid shifting or distortion of form, and the masking method is preferable if the form of the metallized portion is elaborate, or the spacing narrow.

The quantity of metal applied to the fabric will ordinarily be limited to the minimum quantity which will produce the required conductivity or reflectivity as the case may be. This is particularly desirable in cases where weight is an important consideration, as while the weight of metal is a very small fraction of the total weight of the assembly, it is often desirable to hold the weight at the absolute minimum of functionality.

Where strength is the main consideration, as in the construction of the laminates below described, it may be desirable to metallize more heavily.

The resin used for the enclosing envelope may be selected from almost the entire range of known synthetic resins, both thermo-setting and thermo-plastic, and even some naturally occurring resins may be used. The resin should be substantially non-conductive electrically, and at some stage in the fabrication it should reach such state of fluidity as to permeate the cloth and bind the exterior layers of resin solidly together. Given these conditions any preferred resin may be used, the choice being governed by consideration such as cost of material and of fabrication, and the requirements for strength and stiffness in the situation in which the antenna is to be used.

Laminated sheets having a high relation of strength and stiffness to weight may be formed by employing more than one layer of fabric, and various combinations of this type may be produced to meet different requirements.

For example, in the tail elements of an airplane, the use of a light weight antenna which can function as part of the skin of the plane often results in a local saving of weight which effects a highly important reduction in construction cost. For this purpose the plate

may consist of a plurality of layers of uncoated fabric and a single layer (preferably that facing outwardly) of metallized fabric.

A particularly strong and rigid laminated plate may be formed by the use of a plurality of layers of fibre-glass cloth embedded in resin as above described. In such practice it is preferable to metallize all of the fabric layers, as both tensional and flexural strength are markedly increased by the metal coatings.

The reason for this improvement is not entirely certain, though it appears to have its origin in the tendency of the fibres which, in the uncoated cloth, are in contact at the intersections, to abrade and break when they are shifted over each other by tension or flexure. Apparently the metallic coatings lock the intersecting fibres in fixed relative position and thus inhibit this source of loss of strength.

Whatever the reason, it has been found in actual testing methods that a laminate in which the fibre-glass fabric is metallized will often or usually show an increase of more or less seventy percent in tensile strength over a laminate having the same number of uncoated fibre-glass fabric layers, as well as materially enhanced rigidity.

The combination of metallized fabric, and in particular of metallized fibre-glass fabric, with an enclosing envelope of resin, offers marked advantages over other known materials for the fabrication of antennae. Neither the prime materials nor the fabrication are unduly expensive. The metallized cloth or metallized portion may be brought to any desired configuration and, if formed by masking, will positively retain the given form through the molding operation.

Rod antennae, even when of considerable length, are stiff enough to withstand high wind pressure, when supported from one end only. Flat plates may be brought to any desired curvature by pressure at the softening temperature, when formed with the use of a thermoplastic resin. No insulation of the antenna from the supporting means is required, only the projecting conductor which connects with the electrical apparatus requiring insulation. When used for electrostatic shielding, a plate having one layer of coated fibre-glass cloth, when coated on both sides, has the full reflectivity of a polished aluminum plate. And finally, as the entire exterior surface of the antenna consists of non-conductive resin and the coated fabric is sealed except for the projecting connector, leakage and grounding are entirely and permanently prevented if the connector be properly insulated.

WHAT WE CLAIM IS:—

1. A structure adapted to send and receive electrical waves, said structure comprising a sheet of non-metallic woven fabric having metal deposited on a surface in quantity sufficient to render said sheet electrically conductive but insufficient to render said sheet impermeable to fluids, the metallized fabric being encased between layers of a waterproof, solid, electrically non-conductive resin, said layers being bonded together through pores in said fabric and around the periphery of said sheet.

2. Structure as claimed in claim 1, wherein an electrical terminal is electrically bonded at one end to said metallized fabric and projects through the encasing resin.

3. Structure as claimed in claims 1 or 2, wherein said deposited metal is in the form of minute discrete particles in electrically conductive contact.

4. Structure as claimed in claims 1, 2 or 3, wherein said metal is deposited on both sides or surfaces of said sheet.

5. Structure as claimed in claims 1, 2, 3 or 4, wherein said metal is deposited in a desired configuration on only a portion of a side or surface of said sheet and said resin bonds extend beyond the margins of said metallized areas.

6. Structure as claimed in any preceding claim, wherein said woven fabric is fibre-glass cloth.

7. Antennae constructed and arranged substantially as herein described with reference to and as illustrated in the accompanying drawings.

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810814 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

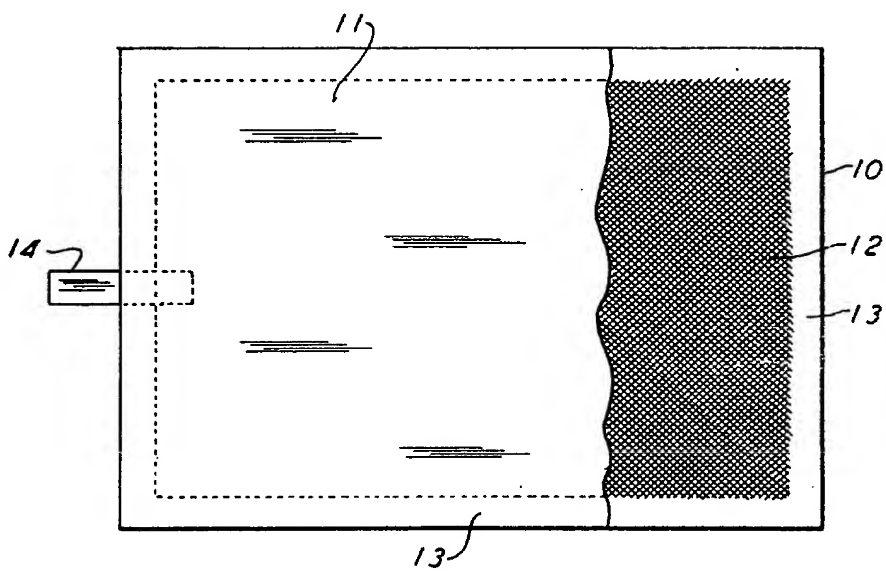

FIG. 1

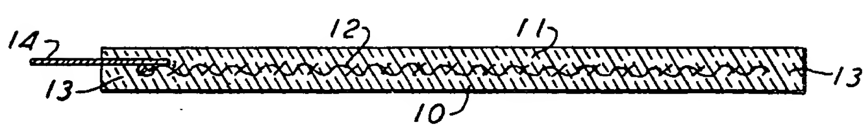

FIG. 2